PSYCHE.

THE MOUTH PARTS OF THE NEMATOCEROUS DIPTERA,—I.

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The repeated attacking of the problem of the homologies of the mouthparts of the Diptera will result in giving us, sometime, a solution. The problem is not inherently insoluble. It is to be solved as other problems in homology have been solved and are daily being solved, namely, by a study of the comparative anatomy and a study of the ontogeny or development of the organ or organs in question. But any such study of homology has inevitably to do with more than the mere determination of homologies: it is inevitably a study of phylogeny.

There are two phases of the work of the student of phylogeny: comparative anatomical study and ontogenetic or developmental study. The study of comparative anatomy includes not only the study of the living members of the group in hand, but also the study of the extinct members, the paleontologic phase. As any organism is simply the sum of its organs, it follows that the phyletic study of a group of organisms resolves itself into a phyletic study of the body organs, and the phylogeny of any one of these organs, fully and correctly worked out, is a great step toward revealing the phylogeny of the group of organisms. For the descent of an organ is synchronous with the descent of an organism.

The determination of the homologies of an organ or group of organs throughout a group of organisms involves the discovery of the primitive, racial, most generalized condition of the organ in the group, and then the various kinds of specialization the organ exhibits, and the paths from generalized to specialized condition for each of these kinds of specialization. This is no more nor less than true phyletic study.

The problem presented us, then, in the homologies of the dipterous mouthparts, so often attacked and in such various ways, seems to me plainly a phyletic problem, and to be solved most expeditiously, if not only, by the rational and accepted methods of systematized phylogenetic investigation. The comparative anatomy of the mouthparts of the living flies (the paleontologic phase of the work is in this case impossible), is to be studied with the aim of determining what is the most generalized

condition of these organs and what the specialized conditions (for because descent is not linear but branching, it is illogical to speak of the most specialized condition; it is wholly possible for several equally "most specialized" conditions to obtain, each the apex of its own kind of specialization [line of descent]). Then are to be determined the lines or tendencies of specialization, and the intermediate conditions are to be arranged along these lines. After the provisional determination of the homologies and phylogeny of the mouthparts by the study of their comparative anatomy, the development or ontogeny of the mouthparts of various flies is to be studied, also with the aim of determining the generalized mouthparts condition and the paths of specialization. The results of the two methods of study should be mutually confirmatory, if a correct interpretation of each is reached.

Of course the two methods of study may, and often are, advantageously carried on more or less nearly simultaneously, the revelations of one phase helping materially to the quicker understanding of the phenomena of the other. Or the ontogenetic study may precede the comparative anatomical. Unfortunately, in practice usually but one phase of the study is prosecuted by a single investigator, limitations of time, or material, or of the capacity of the student restraining him from the full double-phased undertaking.

Having begun the study of the dipterous mouthparts some time ago, I have progressed sufficiently to learn (*a*) that the comparative anatomy of the mouthparts is not an especially difficult study, but that it alone may not certainly determine the homologies of the dipterous mouth, and (*b*) that the ontogenetic study of the mouthparts of Diptera is an especially difficult study.

The Diptera exhibit "complete metamorphosis" in their life history. So thoroughgoing is this metamorphosis, as proved by the studies of Weissman, d'Herculais, Viallanes, Kowalevsky, Van Rees *et al*, on the post embryonal development of Musca, that the beginnings of almost all the imaginal organs are to be looked for in the late larval stages of life. The extraordinary histolysis which is suffered by most of the larval tissues and organs is so far-reaching that most of the imaginal organs develop from small groups of undifferentiated cells, the imaginal buds or histoblasts, which do not begin active development until the fly has reached and spent some time in, its larval stage. This is conspicuously true of the integument and the appendages of the head and thorax; the wings, legs, and the imaginal mouthparts arise from histoblasts whose development from groups of invaginated hypodermal cells into imaginal organs begins only rather late in larval life. The difficulties of the study of the development of the imaginal appendages, and particularly of the mouthparts, is difficult. The development, beginning late, proceeds with

great rapidity: it is obscured by the histolysis of the larval mouthparts going on at the same time with the histogenesis of the imaginal organs, and because there is a marked acceleration of development, by which some of the phyletic stages are crowded together, or perhaps crowded entirely out. So serious are the difficulties in the study of the post-embryonal development of insects with complete metamorphosis, that, although thirty-five years have elapsed since Weissman's first enlightening study of Musca, and although the interest and importance of the study are fully recognized by zoologists and entomologists, only a scant dozen investigations have been at all successfully prosecuted, and our present knowledge of the subject is based on five or six papers on Musca, a couple of studies on Lepidoptera, one on a Hymenopteron and one on a Coleopteron. Most of these papers attempt to trace the development of only certain organs, and in only one of the papers is there an attempt to describe the development of the mouthparts. Künckel d'Herculais in 1875 discovered and briefly described the histoblasts of the imaginal mouthparts of Musca. The course of the development, in any such detail as really to throw light upon the homologies or phylogeny of the Dipterous mouthparts, has yet to be traced.

The other phase, the comparative anatomical phase, of the study of the mouthparts of the Diptera has been far more successfully attacked. Exhaustive accounts of the morphology of the mouthparts of one or of a few species as presented by Kraepelin, Dimmock and others, and comparative studies of the mouthparts of many genera and families, as presented by Becher, Smith, Menzbier, Meinert, and others, combine to make up a large literature on the subject. Most of these papers make the mistake (as it seems to me) of devoting attention largely to a consideration of the more specialized condition of the mouthparts as presented by the brachycerous families, and of attempting to interpret homologies by comparing these conditions with the specialized mouthparts of other highly organized insects, as the Hymenoptera. There seems to be no systematic and thorough search for the most generalized condition of dipterous mouthparts, no attempt to discover the lines of specialization; the studies seem to be little guided by, and take little advantage of, the methods of phyletic study. We know much more about the mouthparts of the Muscidae than of any one of half a dozen of the nematocerous families. And yet entomologists and dipterologists call the Nematocera the generalized Diptera.

The notes I have first to present are simply a contribution to our knowledge of the comparative anatomy of the mouthparts of the nematocerous families of the Diptera. Excepting the Ornephilidae (represented in America by a single, rare and to me so far unobtainable species) I have studied the mouthparts of all of these families. The general condition

of the mouthparts in all of these families is much alike and not difficult to understand. The homologous parts in the mouths of the various Nematocera are readily distinguishable and comparable. These mouthparts as compared with the mouthparts of the specialized Diptera, Musca for example, are distinctly generalized. Now if the parts of the specialized dipterous mouth, as that of Musca, can be homologized with the parts of the generalized mouth, as presented by the Nematocera, then the remaining problem is to homologize the mouthparts of the Nematocera with the mouthparts of other insects, with the racial orthopterous type of mouthparts.

In order that the testimony from the study of comparative anatomy alone may be sufficient to solve our problem it is necessary that (*a*) there be a series of gradatory mouthpart conditions present among Diptera sufficiently continuous to indicate unmistakably the homologies of the mouthparts within the order, and (*b*) that the generalized dipterous mouthparts be sufficiently generalized to admit of a certain comparison and homologizing of the parts with the mouthparts of other insects in whose case the homologies of the mouthparts with those of the racial orthopterous type are authoritatively accepted. Whether these conditions obtain may be, I hope, revealed by the final publication of my studies.

AN UNKNOWN TRACT ON AMERICAN INSECTS BY THOMAS SAY.

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In the library of the Boston Society of Natural History, among the works received from the library of Dr. T. W. Harris, is a tract which seems to have escaped the notice of bibliographers and others. Strangely, it does not even appear in the Catalogue of the Harris Library, (Proc. Bost. soc. nat. hist., vii, 266–271), nor is it contained in the "Complete Writings" of Say, edited by LeConte. It is an octavo pamphlet of seventeen printed and numbered (3–19) pages besides the title page, the reverse of which is blank, and describes for the first time twenty-two insects; of these all but two are redescribed in later papers in the same terms with scarcely a change. The remaining two, however, are not found at all in the Complete Writings and appear to be quite overlooked by subsequent writers, the Pentatoma being unmentioned by Uhler in his Check-list of the Hemiptera Heteroptera of North America (1886), and the Trypeta not being found in Osten Sacken's Catalogue of the described Diptera of North America (1878.)

The title page of the tract reads as follows: Descriptions of new species of North American insects, found in Louisiana by Joseph Barabino. By Thomas Say. March, 1831. Indiana. Printed